

SECTION 11212 - VERTICAL NON-CLOG PUMPS

City of San Diego, CWP Guidelines

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NTS: This specification is intended for CONSTANT-SPEED applications only. Operational strains on shafts, bearings, shaft seals, etc., on variable speed pumps differ greatly from that experienced by pumps operating at constant speed at or near the best efficiency point. A much more rugged pump is required for variable speed applications. It is intended that specification Section 11212 be used for pumps with discharge diameters of 10 to 20 inches which do not exceed 250 hp. These pumps are normally applied in raw wastewater, return- or waste-activated sludge, and other dilute slurry services. This specification is NOT recommended for grit slurry or digested sludge circulation applications. Sections 11218 through 11222 cover variable speed applications and applications that exceed 250 hp.

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PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

- A. **General:** The WORK of this Section includes providing vertical non-clog centrifugal pumps for pumping fluids containing sewage solids, with vertical [constant speed] [two-speed] electric motors, shafts, couplings, and all appurtenant work. Equipment furnished under this Section shall conform to the requirements of this Section and the Related Sections.
- B. **Type:** Pumps shall be the vertical dry pit bottom-suction volute-casing type. Impellers shall be enclosed non-clog Francis or mixed-flow configuration with two or three vanes designed specifically to pump unscreened wastewater with stringy organic solids and grit. The pumps shall be designed so that the impeller, back head and pump shaft can be removed without disturbing the connecting piping, casing, or motor.
- C. **Unit Responsibility:** The CONTRACTOR shall cause the equipment specified under this Section to be furnished by the pump manufacturer, as provided in Section 11000. The CONTRACTOR shall furnish a Certificate of Unit Responsibility Assignment as provided in Section 11175.

1.2 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.
 - 1. Section 11000 Equipment, General Requirements
 - 2. Section 11002 Equipment Supports, Grouting and Installation
 - 3. Section 11175 Pumps, General

1.3 SPECIFICATIONS AND STANDARDS

- A. Specifications and standards shall comply with Sections 11000 and 11175. Where this Section is silent on any subject, item or equipment, the requirements of Section 11175 shall govern.

1.4 SERVICES OF MANUFACTURER

- A. Services of the manufacturer shall be provided in accordance with Section 11175 and as follows:

1. **Inspection, Startup and Field Adjustment:** An authorized service representative of the manufacturer shall visit the site for not less than [] days to check the installation, supervise start-up, and supervise testing and adjustment of pumps.
2. **Instruction of OWNER'S Personnel:** The authorized service representative shall instruct the OWNER'S personnel in the skills required for each Trade Group indicated and the duration indicated. This includes all aspects of pump operation and maintenance, including step-by-step troubleshooting procedures with necessary test equipment. Instruction shall include, but not be limited to, review of operation and maintenance manual; installation and removal of pumps, motors and shafts; service and replacement of bearings; service and flushing of seal water system; replacement and service of seals; daily maintenance requirements; and long-term maintenance provisions. Instruction of the OWNER'S personnel shall be conducted separate from the start-up and testing activities. Each of the OWNER'S Trade Groups will be instructed individually, and no more than six hours will be scheduled in one day. Durations of instruction are:

<u>Trade Group</u>	<u>Class Hours</u>	<u>Field Hours</u>
Electricians	[3]	[3]
Electronics Technicians	[3]	[3]
Operations	[3]	[3]
Plant Maint. Technicians	[3]	[3]

1.5 SHOP DRAWINGS AND SAMPLES

- A. Submittal requirements shall be as set forth in Sections 11000 and 11175.

1.6 OWNER'S MANUAL

- A. OWNER'S MANUAL requirements shall be as set forth in Sections 11000 and 11175.

1.7 FACTORY TESTS:

- A. Each pump shall be factory tested in accordance with the requirements established in Section 11175 and shall be a [witnessed] [non-witnessed] test.

1.8 PUMPED FLUID AND OPERATING CONDITIONS:

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NTS: Provide a concise, but complete, description of the application, describing the pumped fluid, the installation environment, and the method of starting and stopping and operating the pumps in separate paragraphs.

The CITY desires that the pump suction/inlet piping practices recommended in ANSI/HI 9.8, a nationally recognized consensus standard, be incorporated in the design of its projects. Exceptions to this requirement must be submitted in writing to the CITY's project manager, and must be approved in writing by the CITY's project manager in advance of incorporating any exceptions into the design. The performance characteristics of installations that do not conform to the standard are to be confirmed by physical modeling as established in the standard. Physical modeling is expensive and requires months to complete.

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- A. **Pumped Fluid:** The fluid to be pumped is [raw municipal wastewater] [return activated sludge] [waste activated sludge] and is anticipated to range between [64] and [78] degrees F and contain up to [300] [25,000] mg/l of solids consisting of stringy material, rags, plastics, wood, tramp iron, grit and organic material with small quantities of petroleum products and animal fats and greases. Owing to the presence of grit, the fluid is expected to be somewhat abrasive.
- B. **Installation Environment:** The pumps will be installed in a [dry pit] [] and obtain the fluid to be pumped via the indicated piping connected to a [trench type wet well] [] designed in accordance with the requirements of ANSI/HI 9.8.
- C. **System Operation:** The pump will be operated by the control system specified in Section [13300] that will start the pump []. [It is expected this equipment will be used for cleaning the wet well using the method described in ANSI/HI 9.8 on a weekly cycle.]

1.9 PERFORMANCE CRITERIA:

- A. Performance of pumps furnished under this Section shall be guaranteed under the terms of paragraph 11175-1.7C. Field vibration shall be measured in accordance with requirements specified in Section 11175. Non-conforming pumps will be rejected.

PART 2 -- PRODUCTS

2.1 PUMP NAME: [] (P-[] through P-[])

- A. **General:** Vertical non-clog pumps shall conform to the following requirements:

- 1. Number of pumping units - []
- 2. Location - []
- 3. Service - []
- 4. Operation (hours per day) - []

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NTS: For pumps discharging to long new pipelines (over 1,000 feet in length), two system curves shall be developed by the DESIGN CONSULTANT, as recommended in ANSI/HI 9.6.1.5.5.2: one for the system as it will be installed; and a second to represent the condition of the system after some increase in pipe roughness has occurred. Pump design operating condition points shall be specified for the entire range of new and aged pipe conditions, since the pumps will be required to perform satisfactorily for both conditions.

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B. Operating Conditions:

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NTS: Condition A flow should be the result of the targeted maximum flow for the installation divided by the number of pumps in service. Condition A head is the system head at the worst (lowest) assumed 'C' value plus the value of the individual pump losses ('pump correction loss') at the rated flow.

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1. Condition A: Maximum Head Operation (See Notes a and d):

Capacity, gpm	- []
Total head, feet	- []
NPSHA, feet	- []

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NTS: Condition B is the so-called 'runout condition'. Condition B head is the system head at the best (highest) assumed 'C' value plus the value of the individual pump losses ('pump correction loss') at the flow indicated. The flow at condition B head is unique to the individual pump selection so do not list a flow except as provided in Note b.

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2. Condition B: Minimum Head Operation (See Notes b and d):

Capacity, gpm	- from pump H/Q curve
Total head, feet	- []
NPSHA, feet	- []

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NTS: Condition C is the anticipated continuous duty maximum head condition. Condition C head is the system head at the worst (lowest) assumed 'C' value plus the value of the individual pump losses ('pump correction loss') at the flow indicated. The flow at condition C head is unique to the individual pump selection so do not list a

flow. Condition C is optional and is provided to describe a head condition that is not adequately described by Conditions A and B.

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3. Condition C: Continuous Duty Maximum Head Operation (See Notes c and d):

Capacity, gpm	- from pump H/Q curve
Total head, feet	- []
NPSHA, feet	- []

NOTES:

- a. *Condition A shall be taken as the rated, continuous-duty operating condition with the pump operating **against maximum anticipated system head**. Performance at the rated condition shall be guaranteed in accordance with Section 11175. Condition A has been selected to obtain the rated pumping capacity for the installation. It is not intended that the pumps be selected for maximum efficiency at Condition A. Pumps furnished under this Section should be selected to achieve Condition A performance, but also operate continuously without objectionable vibration or cavitation at the head specified under Condition B. Condition A may be located in the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*

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NTS: While the flow used to establish Condition B should not be listed in the Operating Conditions table, it should be inserted into the blank in Note b to indicate the basis for the NPSHA information.

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- b. *Condition B head is presented to indicate operating conditions when the pump is operating **at minimum anticipated system head**, assuming a hypothetical head-capacity curve. Pumps with head-capacity curves steeper than that assumed will produce less flow at lower head. The reverse will occur with pumps having a shallower head-capacity curve. **Condition B shall be used for pump selection. Condition B shall be located within the Preferred Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.** NPSHA, as listed for Condition B is calculated on a pumped flow of [] mgd.*
- c. *Condition C is the **anticipated continuous duty maximum head condition**. Pumps furnished under this specification shall be capable of sustained (24 hours per day) operation at this condition within the requirements set forth in Section 11175. Condition C shall be located within the Allowable Operating Region as established by the pump manufacturer in accordance with ANSI/HI 9.6.3 and listed in the manufacturer's published application data for the specific model proposed for this application.*

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NTS: NPSHA data is dominated by considerations associated with the pump setting (elevation). Therefore, it is imperative that the drawings show the elevation of the pump inlet piping (not the centerline of the pump inlet flange) for use by the pump

manufacturer in responding to NPSH margin requirements. To avoid the potential for conflict, do not list the centerline elevation in the Specifications. Section 11175 places restrictions on NPSH margin (NPSHA/NPSHR). The design engineer, specifier and submittal reviewer should become completely familiar with these requirements and the procedures established in ANSI/HI 9.6.1 to make certain that the design incorporates a setting that will allow all reasonable candidate pump designs to comply with these restrictions and rule out those designs that do not. ***Bear in mind: NPSHA must exceed NPSHR by a wide margin at all specified operating conditions and that this margin requirement will vary depending on several considerations. The bottom line with respect to installation costs is that the greater the NPSHR for a given pump, the lower a pump must be below the inlet hydraulic gradient.*** The specifications, under Section 11175, require the pump manufacturer to demonstrate by calculation and supporting documentation that the proposed pump meets the NPSHA/NPSHR margin limitations established in the specification and in ANSI/HI 9.6.1.

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- d. *Total head in the above tabulation is the algebraic difference between the discharge head and suction head as defined in ANSI/HI 1.1 – 1.6. Net positive suction head available (NPSHA) in the above tabulation is referred to the pump inlet piping at centerline elevation (project datum) as shown and is calculated in accordance ANSI/HI 1.3 for average barometric pressure and maximum temperature conditions. NPSHA at the pump impeller eye can be determined by adjusting the given value by proposed pump dimensions and the indicated requirements for pump installation details. An allowance of five feet has been included for the presence of volatile constituents in the pumped fluid. Required NPSHA margin shall be as specified in Section 11175.*

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NTS: The maximum anticipated surge pressure is of importance in applications where surge pressures may exceed nominal pressure ratings for off the shelf pump designs. In such instances, ductile iron or cast steel may be required for pressure retaining parts. Delete this note if this is not an issue.

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[e. *Maximum expected surge pressure is [] psig.*]

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NTS: Note that all specified operating conditions require net positive suction head (NPSH) information. Provide NPSHA information for any added operating conditions.

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C. Design Requirements:

1. **General:** The pumps shall be specifically designed to pump the fluid described in paragraph 11212-1.8, and shall comply with the requirements specified in Section 11175.

The analysis specified under paragraph 11175-1.10, Rotor and Critical Speed Analysis and System Design, will not be required for pumps furnished under this Section.

The pumps shall be provided with suitable lifting hooks and a hoist sling, if required, so that each pump can be removed in one piece. [It shall be the manufacturer's responsibility to ensure that each pump can be lifted to the ground floor using the hoist equipment included in the design.]

2. Minimum solid sphere capable of passing through pump (in. dia.) - []
3. Max pump efficiency at max speed, min (percent) - []
4. Max pump speed (rpm) - []
5. Max motor size (hp) - []

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NTS: Depending on the method of driving the pump, another line may be needed to indicate motor speed or other considerations.

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- [6. Max motor speed (rpm) - []]

D. Pump Dimensions:

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NTS: Avoid velocities at pump inlet connections greater than about 14 ft/sec if possible.

Note: ANSI/HI 9.8, at paragraph 9.8.4, limits velocities in the piping approaching the pump to 8 ft/sec. In addition, the standard also dictates a straight section of not less than five nominal pipe diameters downstream from any valve or fitting and upstream from any size reduction for the pump inlet connection.

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1. Min size of suction flange (in) - []
2. Min size of discharge flange (in) - []
3. Flange rating (psi) - []

2.2 PUMP REQUIREMENTS

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NTS: Pump construction is covered in Section 11175, which relies upon API 610 for basic requirements for materials and features. The DESIGN CONSULTANT should

verify that the referenced API 610 requirements are suitable for the specific application, and list exceptions in the following paragraphs.

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- A. **General:** Construction of vertical non-clog pumps shall conform to the requirements set forth in Section 11175, except as described in the following paragraphs.
- B. **Materials:**
1. Seal - Split mechanical seal per Section 11175
- C. **Drive:** [Direct drive] [two-speed drive] [closed coupled] [with extension shaft], with vertical, heavy-duty, electric motor suitable for [460]-volt, [3]-phase, 60-Hz ac power supply, in accordance with Section 16040. The motor shall be supported [on the pump] [independently on structural members] [on the floor above].
- D. **Equipment Features:**
1. **Impeller and Casing:** The impeller shall be an enclosed non-clog Francis or mixed-flow configuration with two or three vanes and front and rear shrouds. Semi-open impellers will not be allowed. The leading edges of the impeller vanes and casing cutwater shall be smooth and rounded and configured to avoid accumulation of stringy materials and to pass solids. Impeller passages shall be designed specifically to pass solids found in unscreened municipal wastewater and to avoid cavitation. Vane overlap shall be minimized to permit efficient release of solids to the volute passages. All water passages shall be smooth and free from hollows, cracks, pin holes and projections. The impeller shall be firmly keyed to the shaft and held firmly in place by a threaded, cast stainless steel locknut designed to prevent stringy material from catching on it.
 2. **Pump Casing Support:** The pump casing shall be designed to be supported on concrete piers cast into the pump room floor. Fabricated steel support frames will not be acceptable for mounting the pump. Details of the mounting system shall conform to the requirements of Section 11002.
 3. **Backhead:** The backhead shall be self-centering and shall permit back pullout. All horizontal surfaces in the backhead shall be sloped to the drain connection.
 4. **Pump Frame:** The frame shall be designed to distribute forces from the bearing housings into the casing and shall consist of angled struts extending from the thrust bearing housing to the casing. An intermediate, horizontal strut shall be provided to carry radial bearing loads. Openings in the frame shall be provided to permit access to the seal. The connection between the backhead and frame shall have self-centering and registering fits. Tubular bearing frames will not be permitted. A tapped drain connection shall be provided to permit field connection to an external drain. The seal box shall be drilled and tapped for seal flushing.

2.3 MANUFACTURERS

- A. Pursuant to the limitations described in paragraph 11000-2.1D, candidate pump manufacturers include [Fairbanks Morse, Ingersoll Dresser, Aurora, Morris, and Patterson], or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. Pumping equipment shall be installed in accordance with approved procedures submitted with the shop drawings and as indicated.
- B. General installation requirements shall be as indicated in Section 11175.

**** END OF SECTION ****